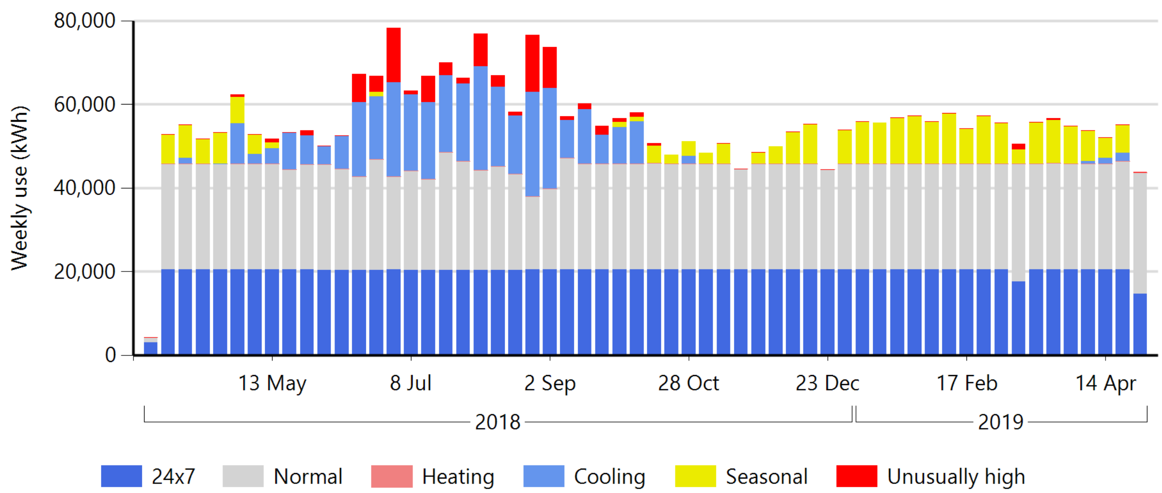
ENERGY ai®
Actionable Information for Energy Savings

Meter Insights for Central Plant

Commodity: **Electricity**
Analysis Period: **31 March 2018 - 2 May 2019**
Prepared for: **Mid Atlantic Manufacturing**
Report Date: **12 June 2019**

Electricity use over the analysis period. Each bar is the use for one week:



Potential Savings Opportunities

$12,900 36% of all electricity use appears to be "24x7" load - from equipment which is almost never turned off. Reducing this continuous demand by 10% (12.2 kW) would save about $12,900 per year.

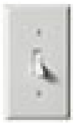
$12,500 There are 14 "on" hours per day for most Mondays-Fridays. These are consecutive hours when electricity use is much higher than during "off" hours. Reducing the number of "on" hours by one hour per day on Mondays-Fridays would have saved about $12,500 over the analysis period.

$10,400 Electricity use was higher than expected for 866 hours over the analysis period. Eliminating the excess use would have saved an estimated $10,400. Much of this high use occurred on Saturdays, Sundays when the load rose instead of remaining flat or dropping as expected.

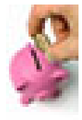
$4,170 10% of all electricity use is driven by warm weather. Actions described later in the report would have saved about $4,170.

$2,830 7% of all electricity use occurs during a seasonal rise which peaks in late winter. This appears to be caused by some factor or activity unrelated to weather. A 10% reduction in this use would have saved about $2,830.

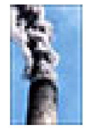
In combination, these actions would have the following impacts:



Avoided use:
350,000 kWh



Cost savings:
$42,800



Avoided CO_2 emissions:
266,000 lb

Load Components

The preceding chart shows electricity use divided into six components:

24x7 Load may be from equipment which is almost never turned off. It comprises 36% of total electricity use at an estimated cost of $140,000.

Normal Electricity use above the 24x7 level but within the expected range for this load. It comprises 44% of total use at an estimated cost of $173,000.

Heating Electricity use is not affected by cold weather.

Cooling Electricity use increases with warm weather, totalling 10% of all use. This added an estimated $41,700 to the electricity bill.

Seasonal There is a seasonal increase in electricity use peaking in late winter. This increase accounts for 7% of the total use, at an estimated cost of $28,300.

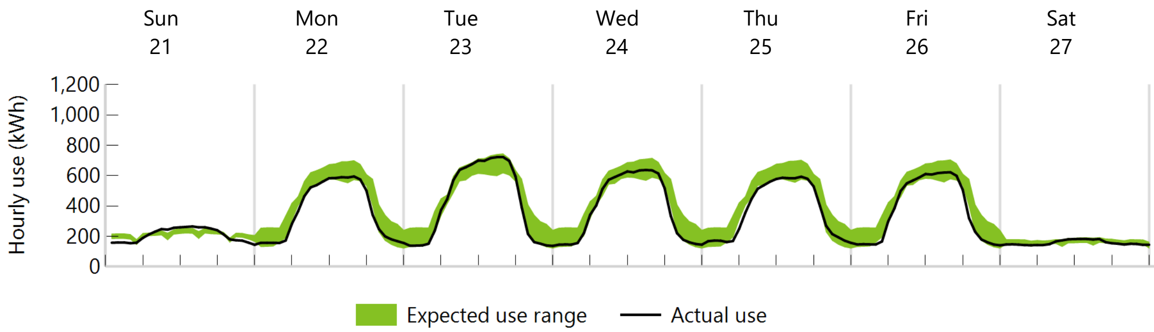
Unusually high Electricity use was higher than expected for 866 hours during the analysis period. This is 3% of the total use, with an estimated cost of $10,400.

The following sections of this report provide more details about each load component.

Typical Load Profiles

Energy use follows a standard weekday-weekend pattern: highest use on Mondays through Fridays, lower use on Saturdays and Sundays. Based on the average electricity price over the analysis period, the daily cost for a weekday is $657 higher than for a weekend.

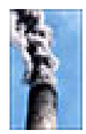
The week beginning Sunday, 21 April 2019 is typical:



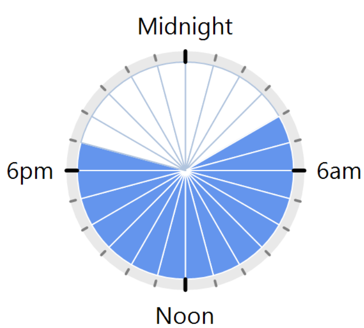
There are 14 “on” hours per day for most Mondays-Fridays. These are consecutive hours when electricity use is much higher than during “off” hours. Reducing the number of “on” hours by one hour per day on Mondays-Fridays over the analysis period would have the following impacts:

Avoided use:
103,000 kWh

Cost savings:
$12,500



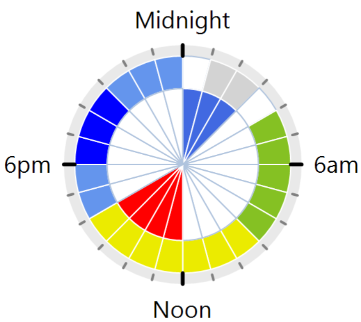
Avoided CO_2 emissions:
78,600 lb



There are 14 “on” hours per day for most Mondays-Fridays, starting at 4am and ending at 7pm. They are shown on the left, shaded blue.

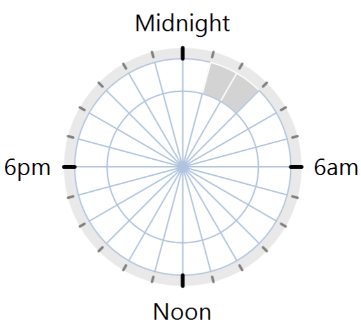
Some days of the week follow a common pattern throughout the analysis period. They rise and fall at about the same time of day, and peaks and minimums tend to occur at about the same time. The most common characteristics are listed below:

Mondays-Fridays



- 1am to 3am - load remains mostly flat (58% of Mondays-Fridays).
- 4am to 4pm - load rises, most steeply from 4am to 9am (83%).
- Peaks between Noon and 4pm (93%).
- 4pm to Midnight - load drops, most steeply from 6pm to 9pm (91%).
- Daily low occurs between Midnight and 3am (78%).

Saturdays, Sundays

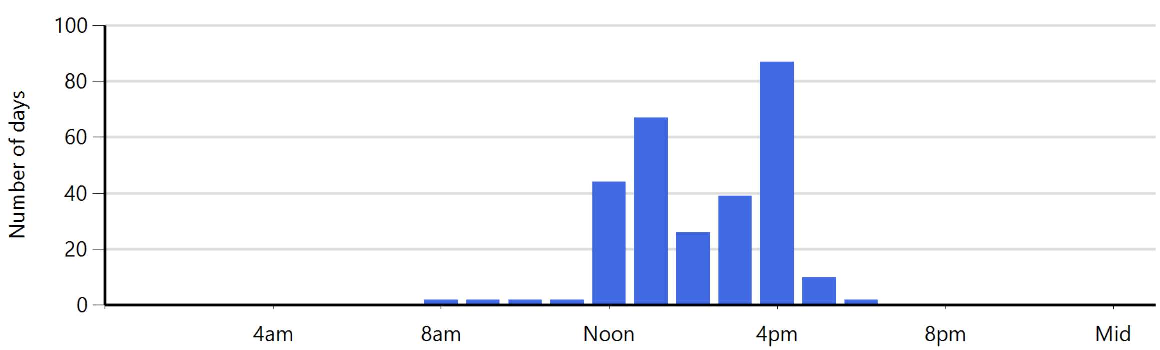


- 1am to 3am - load remains mostly flat (61% of Saturdays, Sundays).

Inner hours: Daily low, Daily peak

Outer hours: Drop, Steep drop, Flat, Rise, Steep rise

As noted above, the highest daily peak demand for Mondays-Fridays usually occurs between Noon and 4pm. The following chart shows when the daily peak occurs for all Mondays-Fridays. A 3pm peak means that the highest reading for the day is between 2:30pm – 3:30pm.



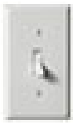
24x7 Load

36% Percentage of total electricity use from equipment which is almost always on.

122 kW Lowest average hourly demand to which this load drops during “off” hours.

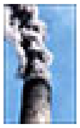
$140,000 Estimated cost for this “24x7” load.

A 10% reduction in this load for a full year would have the following impacts:



Avoided use:
106,000 kWh

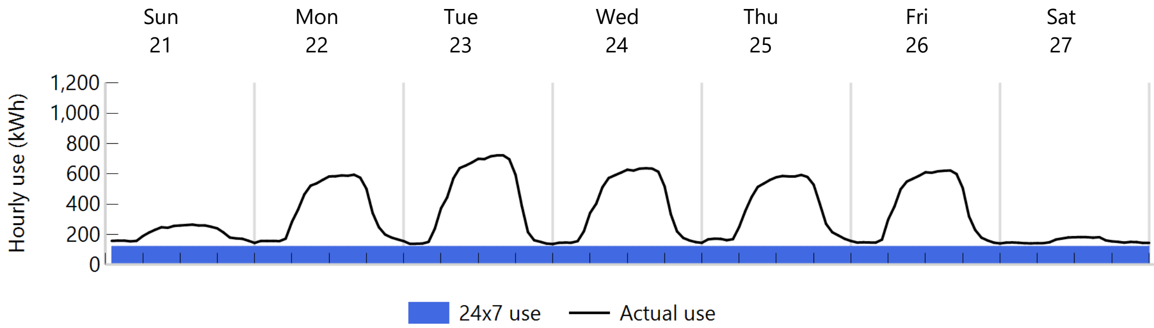
Cost savings:
$12,900



Avoided CO_2 emissions:
81,100 lb

The 24x7 load is usually created by equipment that is almost never turned off. Some of this load is unavoidable, like data centers, safety equipment, and security systems. But other continuous loads like circulating pumps can be reduced with controls. Standby, or “phantom” power from computers and appliances when they are supposedly off may also be a significant source of 24x7 load.

The 24x7 demand for this load is 122 kW. The week beginning Sunday, 21 April 2019 illustrates the percentage of total electricity use at or below the 24x7 demand:



The load drops to or below the 24x7 demand for 325 hours over the analysis period (3%). Most of these hours occur on Saturdays.

Weather Impact

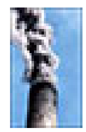
$41,700 Estimated cost of electricity use driven by warm weather. This is 10% of total electricity use over the analysis period.

60°F Electricity use on Mondays-Fridays increases when the average daily outdoor temperature rises above 60°F. Warm weather adds $29 per day for each °F above 60°F. If the average outdoor temperature is 70°F, daily costs increase by about $290.

The actions detailed below will reduce the impact of weather on electricity use, and would have provided the following savings over the analysis period:

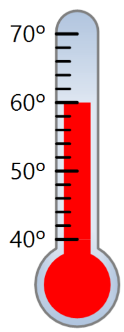
Avoided use:
33,400 kWh

Cost savings:
$4,170

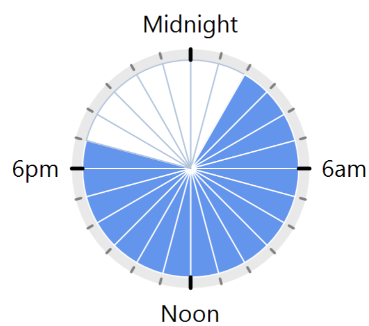


Avoided CO_2 emissions:
25,400 lb

Actions to reduce the impact of weather



Cooling balance point for Mondays-Fridays is 60°F.



The hours when cooling occurs for Mondays-Fridays are shaded blue, setback hours when cooling is usually off are white.

Cooling balance point

- Mondays-Fridays - the cooling balance point is 60°F. This is in the normal range, no action is recommended.

Reduce cooling cost per degree

- Mondays-Fridays - the cooling cost per degree is $29. A 10% improvement in cooling efficiency from the actions described below is readily achievable in many facilities. Lower the cooling cost per degree by 10% to $26.

Setback schedule

- Mondays-Fridays have 7 cooling setback hours.

Examples of operational and other facility changes which reduce the impact of weather on electricity use include the following:

Cooling balance point
Electricity use increases when the daily average outdoor temperature rises above the "cooling balance point". Actions which lower your cooling balance point reduce energy use from warm weather. These include

- Raising the cooling setpoint on thermostats
- Increasing the insulation levels in ceilings, walls, and floors
- Replacing windows with more energy-efficient models

Cooling cost per degree
A simple way to describe the overall efficiency of a cooling system is "cooling cost per degree". This is the additional cost per day for each degree that the daily average outdoor temperature is above the cooling balance point. For example, if the cooling cost per degree is $10, and its cooling balance point is 60°F, then $100 is added to the electricity bill on a day whose daily average outdoor temperature is 70°F. Actions which lower your cost per degree reduce energy use from warm weather. These include

- Regular maintenance of the cooling systems, such as replacing filters, fan and pump motor maintenance, etc.
- Sealing and insulating ducts and pipes
- Replacing old cooling systems with more efficient equipment
- Increasing the insulation levels in ceilings, walls, and floors

Cooling setback schedule
Cooling should only occur when the facility is in use. Setback controls or thermostats reduce cooling during unoccupied hours of the day and week. Applying setbacks whenever possible will reduce energy use from warm weather.

Unusually High Use

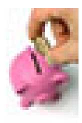
866 hours Number of hours over the analysis period in which electricity use was higher than expected.

3% Percentage of total electricity use from this unusually high use.

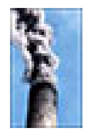
Sat, Sun 30% of the high use occurred on Saturdays, Sundays when the load rose instead of remaining flat or dropping as expected.

If electricity use had not exceeded the expected range over the analysis period, the following savings would have been realized:

Avoided use:
82,800 kWh

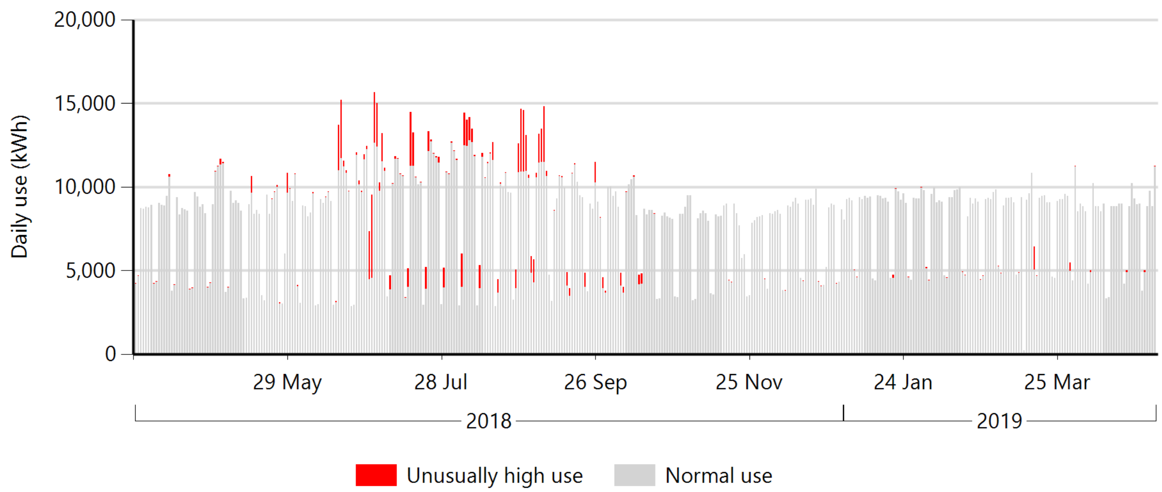


Cost savings:
$10,400



Avoided CO_2 emissions:
63,100 lb

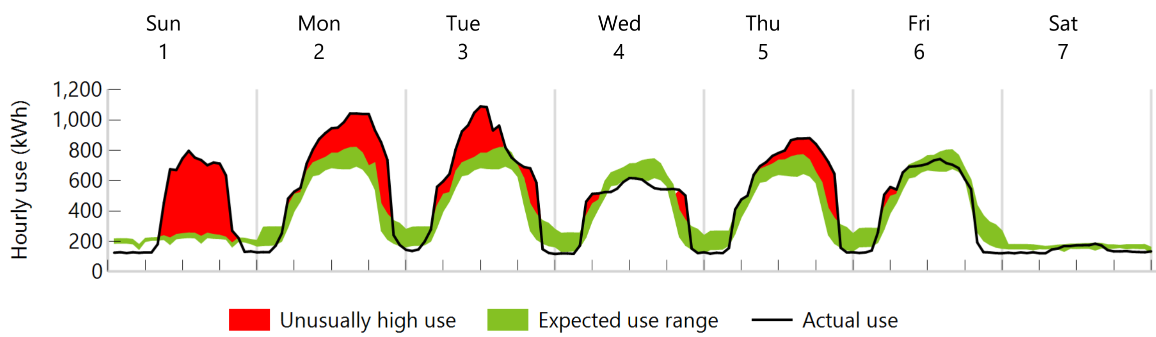
Electricity use over the analysis period. Each bar is the use for one day:



Unusually high use occurs when actual use exceeds the expected range for one or more hours in a day. This can happen when the load rises instead of remaining flat or falling, suggesting that equipment was turned on at unusual times. It can also happen when load stays flat instead of dropping as expected, as when office lights are not turned off at the end of the work day.

A detailed analysis of unusually high usage patterns can distinguish between “equipment turned on” and “equipment not turned off”:

77% Percentage of the excess use caused by the load unexpectedly rising (“equipment turned on”). An example is the 12 hour period beginning at 9am on Sunday, 1 July 2018:



Much of the excess use occurred at similar times during the analysis period:

Sat, Sun 34% of the high use occurred on Saturdays, Sundays.

All instances of unusually high use are shown in the Load Calendar at the end of this report. The largest events are listed below:

Start and end times	Length (hours)	High use (kWh)	Cost of high use ($)
9am 1 Jul - 8pm 1 Jul 2018	12	5,000	633
5am 28 Aug - 7pm 28 Aug 2018	15	3,730	469
4am 29 Aug - 7pm 29 Aug 2018	16	3,660	460
Midnight 18 Jun - 9pm 19 Jun 2018	22	3,660	468
5am 6 Sep - 7pm 6 Sep 2018	15	3,330	413
4am 16 Jul - 7pm 16 Jul 2018	16	3,220	407
5am 2 Jul - 9pm 2 Jul 2018	17	3,040	385
10am 30 Jun - 8pm 30 Jun 2018	11	2,870	367
4am 18 Jun - 6pm 18 Jun 2018	15	2,580	330
4am 30 Aug - 7pm 30 Aug 2018	16	2,150	270

Seasonal Load

Late winter Electricity use was higher during a period of 48 weeks peaking in late winter.

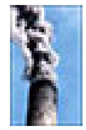
7% Percentage of total electricity use from this seasonal increase.

$28,300 Estimated cost of the seasonal increase.

A 10% reduction in this seasonal load would have had the following impacts:

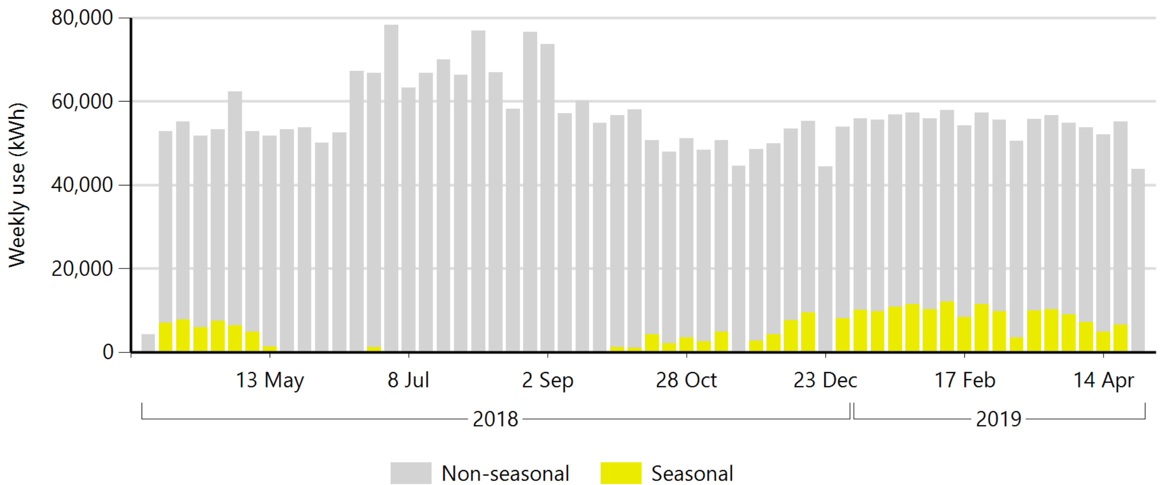
Avoided use:
23,800 kWh

Cost savings:
$2,830



Avoided CO_2 emissions:
18,100 lb

Electricity use over the analysis period. Each bar is the use for one week:



The seasonal increase began in late March and ended 48 weeks later in early May. It peaked in early April. Seasonal use is not affected by weather.

Shutdowns

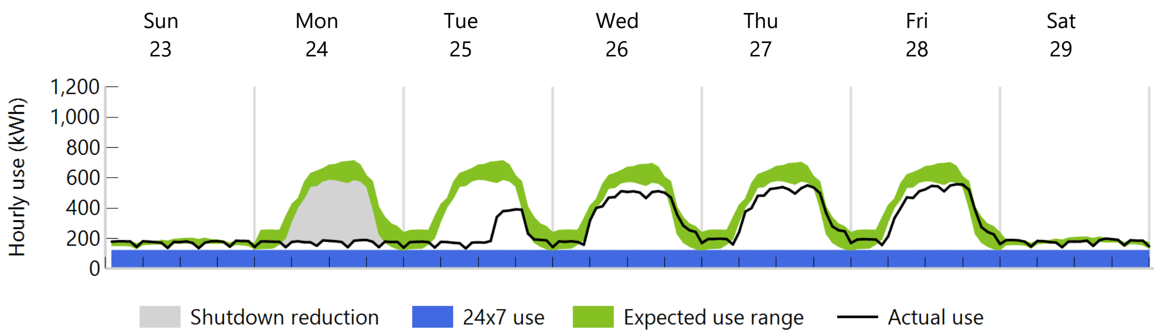
1 day Number of "shutdown" days in the analysis period - electricity use was much lower than expected, and was flat for most of the day.

4,960 kWh Reduced electricity use during the shutdown days. If use had been in the "expected range" for these days, this is how much additional electricity would have been used.

$595 Estimated cost savings from the reduced electricity use.

A "shutdown day" occurs when equipment which can be turned off is shut down for most hours of the day. This is a day when the load is expected to rise and fall, but instead is flat and near the 24x7 demand. Shutdown days often occur around holidays.

For example, the week beginning Sunday, 23 December 2018 has one shutdown day:



The shutdown day occurred on:

Shutdown Period	Reduced use (kWh)	Reduced cost ($)	Holidays
Mon, 24 Dec 2018	4,960	595	

If you expected other days not listed above to qualify as shutdown days, they may have been excluded because their load did not drop enough, or it fluctuated too much throughout the day. You can see the load profile for all days in the Load Calendar.

The Basics

This analysis is based upon 60 minute kWh data spanning 398 days. Totals for this period are:

3,240,000 kWh	Total electricity use over the analysis period.
1,140 kW	Peak demand over the analysis period. This occurred at 5:00pm 6 September 2018.
$393,000	Estimated total electricity cost.
2,470,000 lb	CO_2 emissions from this use.

Energy Prices

Source for energy prices: US EIA Monthly Average Retail Price of Electricity to Commercial Customers in New Jersey

CO_2 Emission Factors

Greenhouse gas emissions resulting from direct and indirect energy use are calculated using average factors of “equivalent” CO_2 per unit of energy use. Equivalent CO_2 includes carbon dioxide and other greenhouse gases.

Source for CO_2 emission factors: eGRID Subregion Emission Factor for RFCE (RFC East)

The emission factor(s) in effect over the analysis period are shown below.

Effective date	Emission factor (lbs/MWh)
1 January 2016	762

Each emission factor is applied to energy use for all days beginning on its effective date, and ending on the day before the next effective date. If the effective date for the last factor is earlier than the end of the analysis period, the last factor is used for all remaining days in the analysis period.

Weather Data

Source for daily average outdoor temperature: U.S. National Climatic Data Center "Global Summary of the Day". The weather station name is "NEWARK INTL AIRPORT" located at latitude 40.683N and longitude 74.169W.

Load Calendar

The Load Calendar shows hourly usage patterns for every day in the analysis period, 31 March 2018 - 2 May 2019. The following information is displayed in the Load Calendar:

Actual use (kWh)
Electricity use totalled for each hour. For example, the “2pm” value is the total use for the hour ending at 2pm of that day. If a reading straddles two hours, then its use is prorated to each, based on the number of minutes that occur in each hour.

Expected use range (kWh)
If electricity usage followed the patterns described in the “Typical Load Profiles” section, it would fall within this range of hourly kWh. The range is calculated by day of week from the most common patterns over the analysis period. It shows how usage rises and falls, and when peaks and valleys most often occur.

24x7 use (kWh)
Electricity use from equipment which is almost never turned off, as described in the “24x7 Load” section. This is determined from an analysis of the lowest average hourly demand for each week. Note that if this load has no 24x7 use, then the “24x7 Load” section is excluded from this report.

Cold weather use (kWh)
Increased electricity use when the average outdoor temperature dropped below the heating balance point shown in the "Weather Impact" section. Note that if this load is not affected by weather, then the "Weather Impact" section is excluded.

Warm weather use (kWh)
Increased electricity use when the average outdoor temperature rose above the cooling balance point shown in the "Weather Impact" section. Note that if this load is not affected by weather, then the "Weather Impact" section is excluded.

Unusually high use (kWh)
Electricity use which exceeds the upper limit of the expected range, as described in the “Unusually High Use” section. Note that if the load has no unusually high use, then this section is excluded from the report.

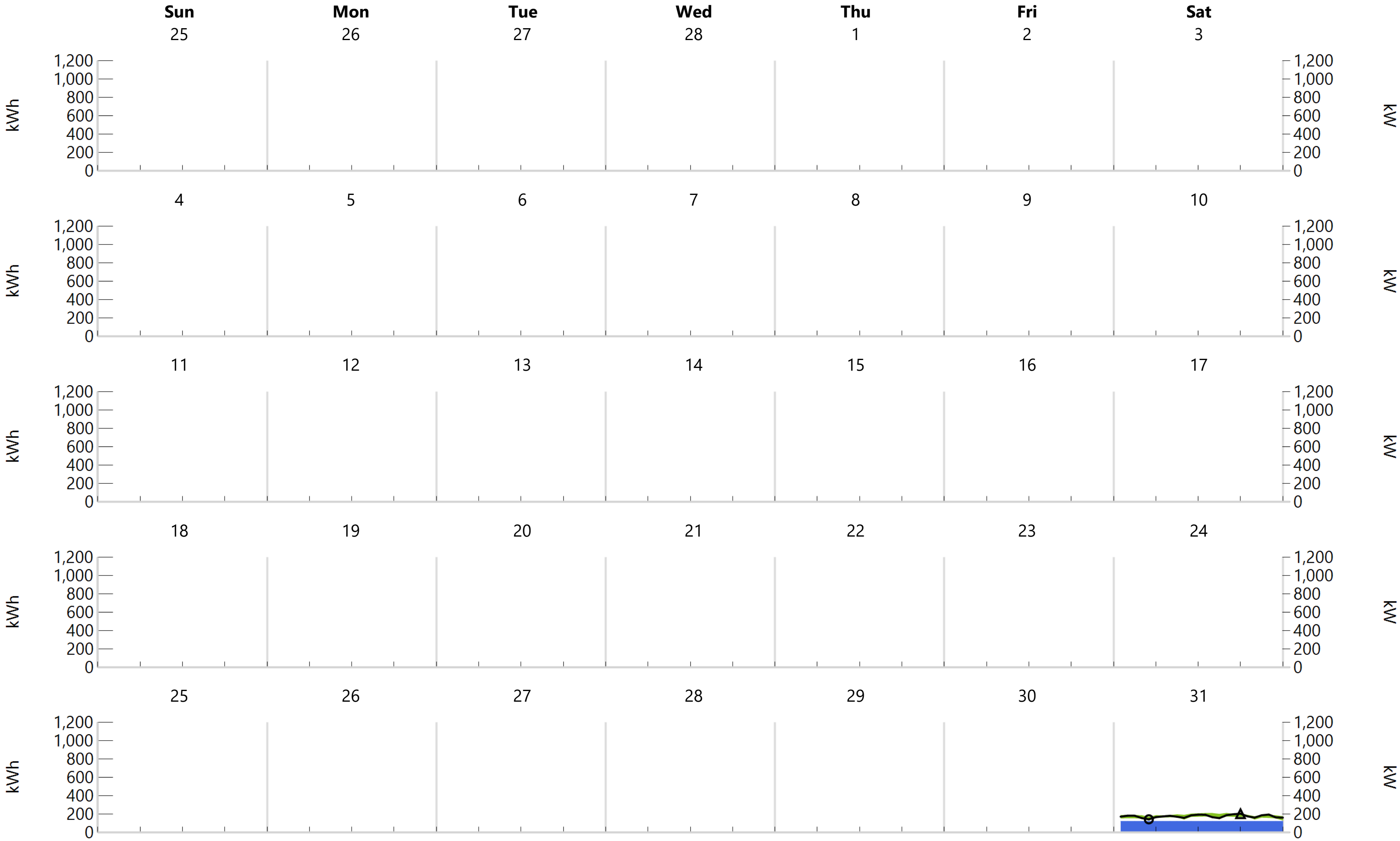
Shutdown days (kWh)
These are days when electricity use is much lower than expected and flat for most hours, as described in the “Shutdowns” section. They often occur on or near holidays. Note that if this load has no shutdown days, then the “Shutdowns” section is excluded from this report.

Peak demand (kW)
Highest demand reading for each day. This is not necessarily the same hour which has the highest use for the day. For example, if the readings for a load have 15 minute intervals, then there are 4 readings for each hour. One of these may be the highest reading for the whole day, but when converted to energy use and added to the other three intervals in the hour, the total may not be largest hourly use for the day.

Minimum demand (kW)
Lowest demand reading for each day. This is not necessarily the same hour which has the lowest use for the day.

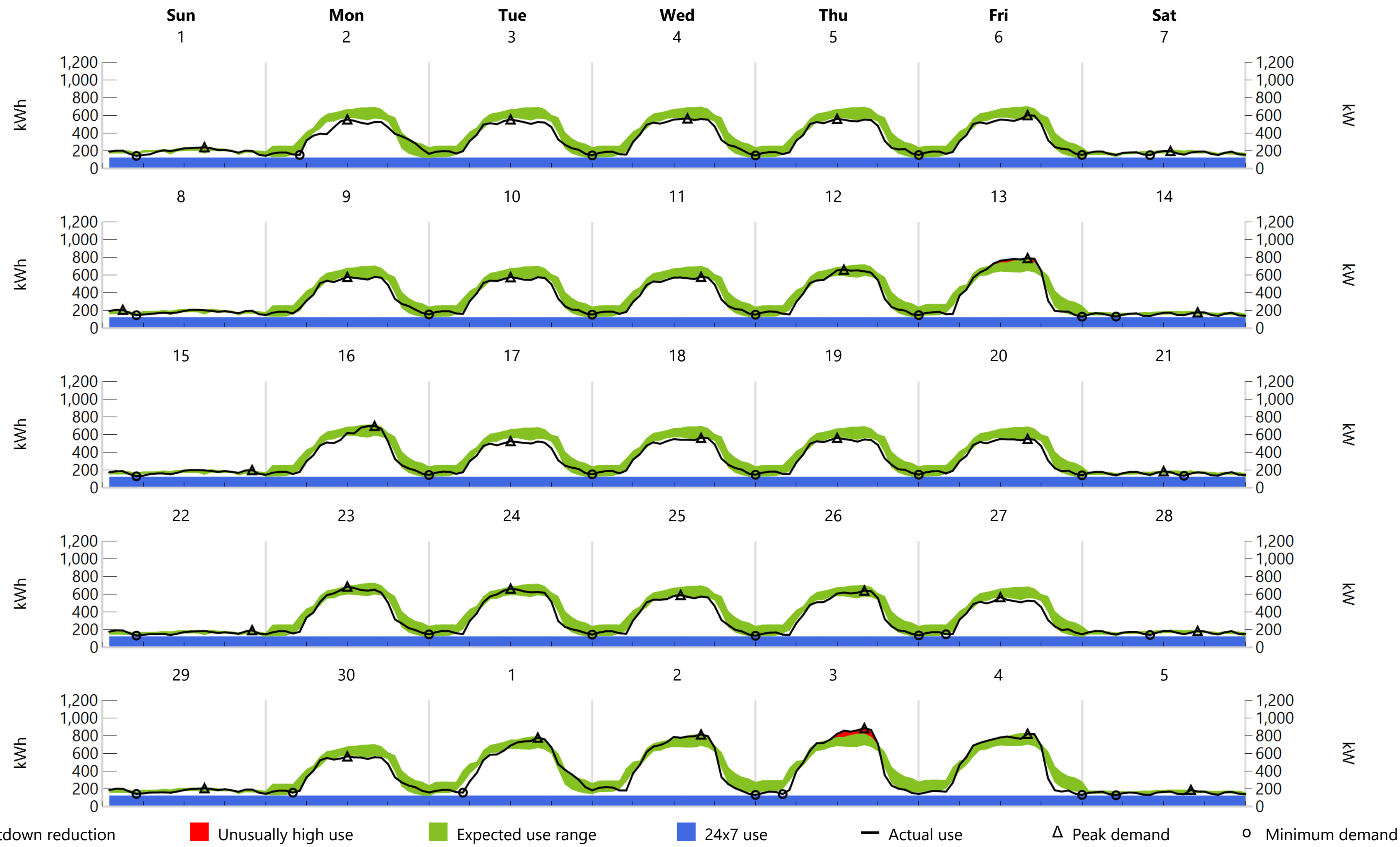
Gaps in the Load Calendar result from missing or excluded data, as described in “The Basics” section.

Load Calendar for Central Plant - Electricity
March 2018

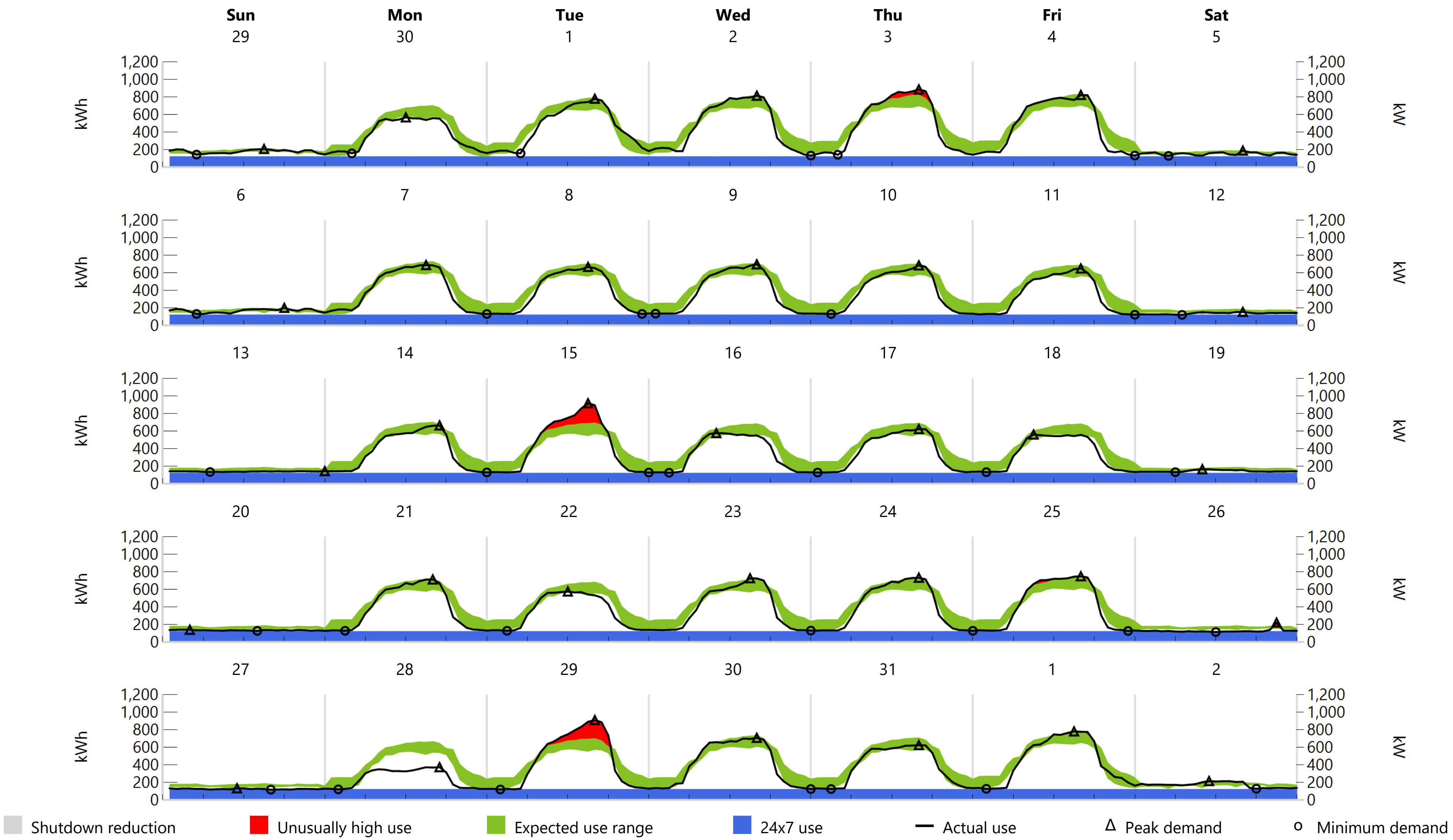


Shutdown reduction | Unusually high use | Expected use range | 24x7 use | Actual use | Peak demand | Minimum demand

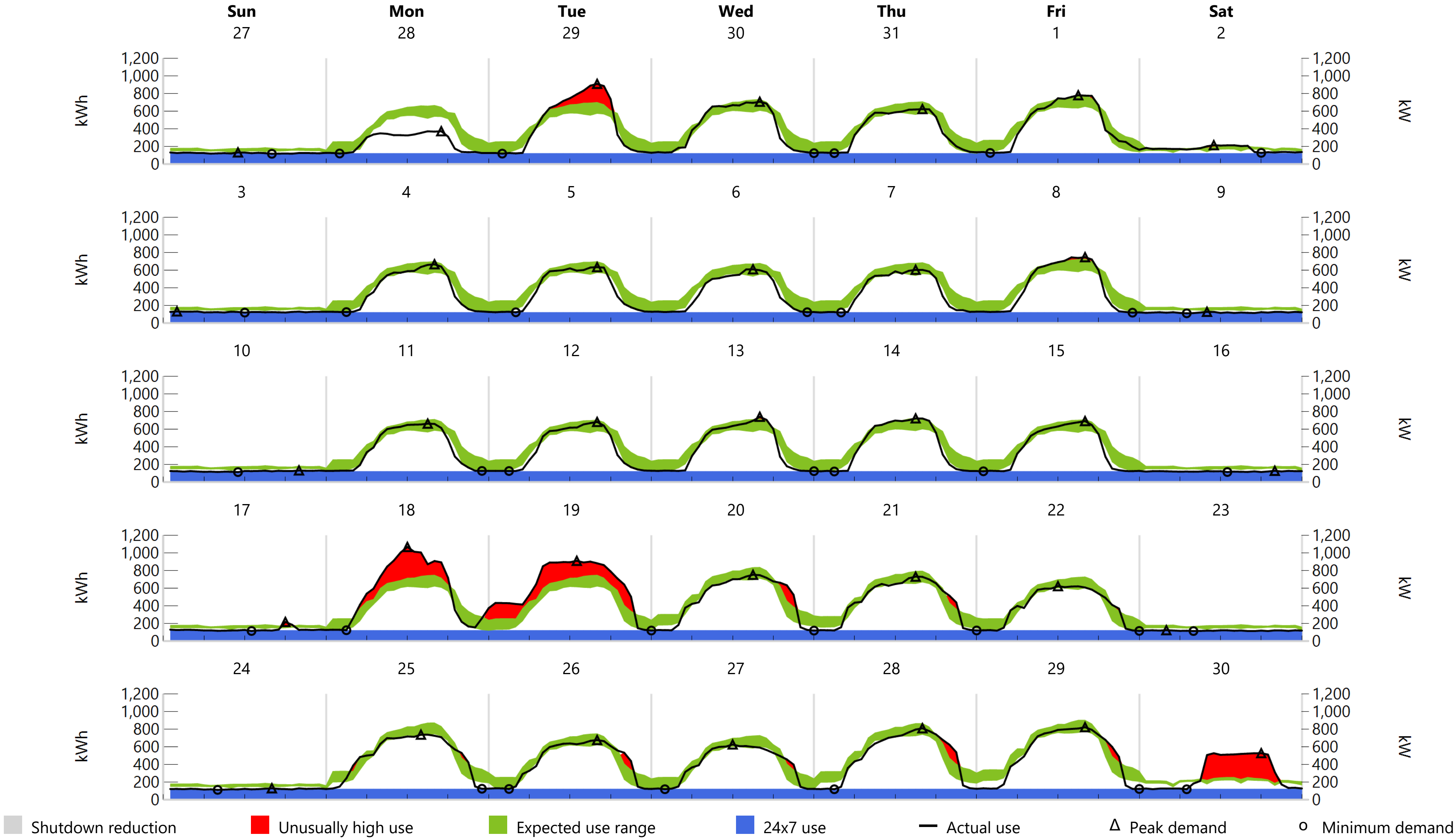
Load Calendar for Central Plant - Electricity
April 2018



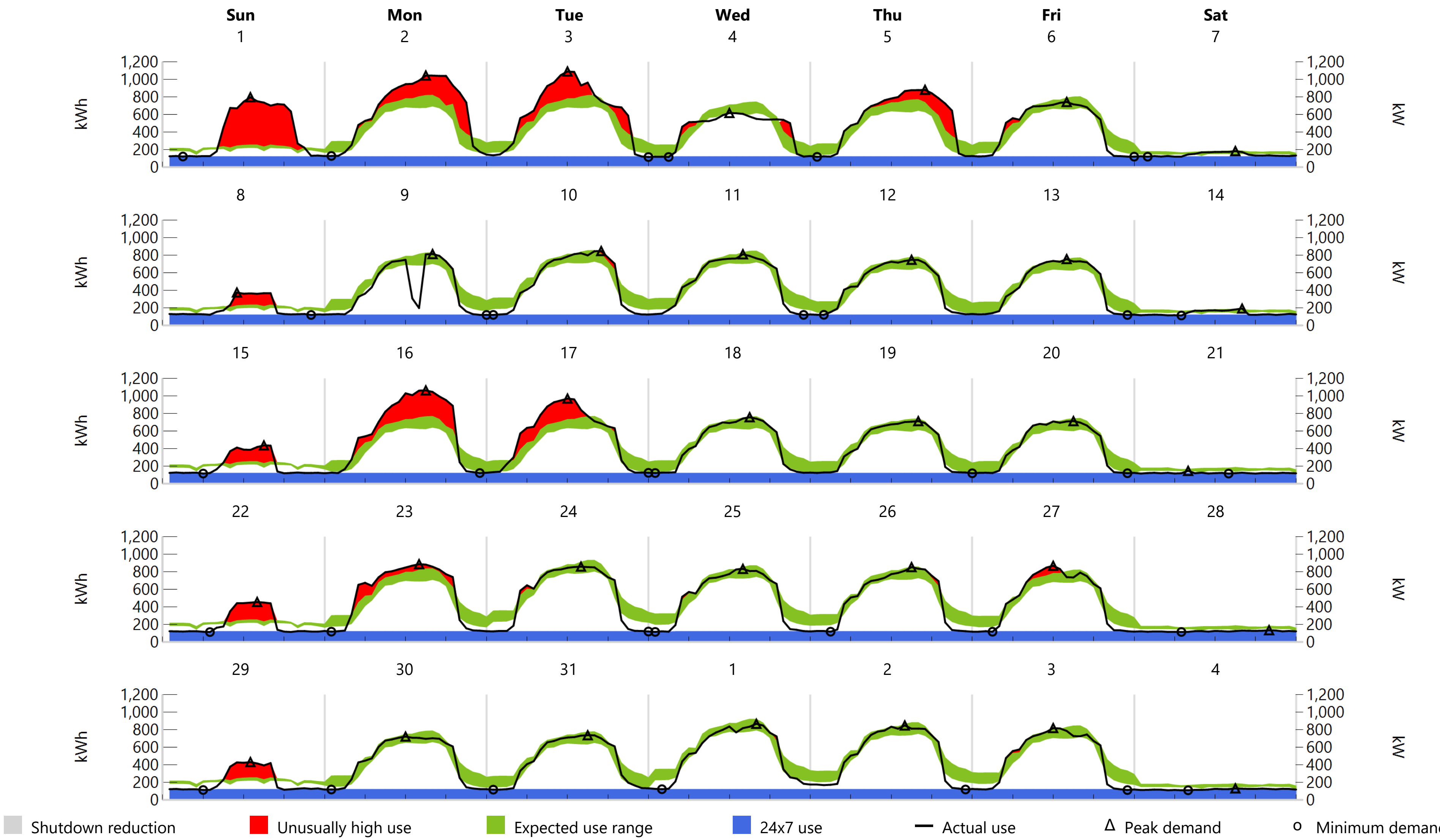
Load Calendar for Central Plant - Electricity
May 2018



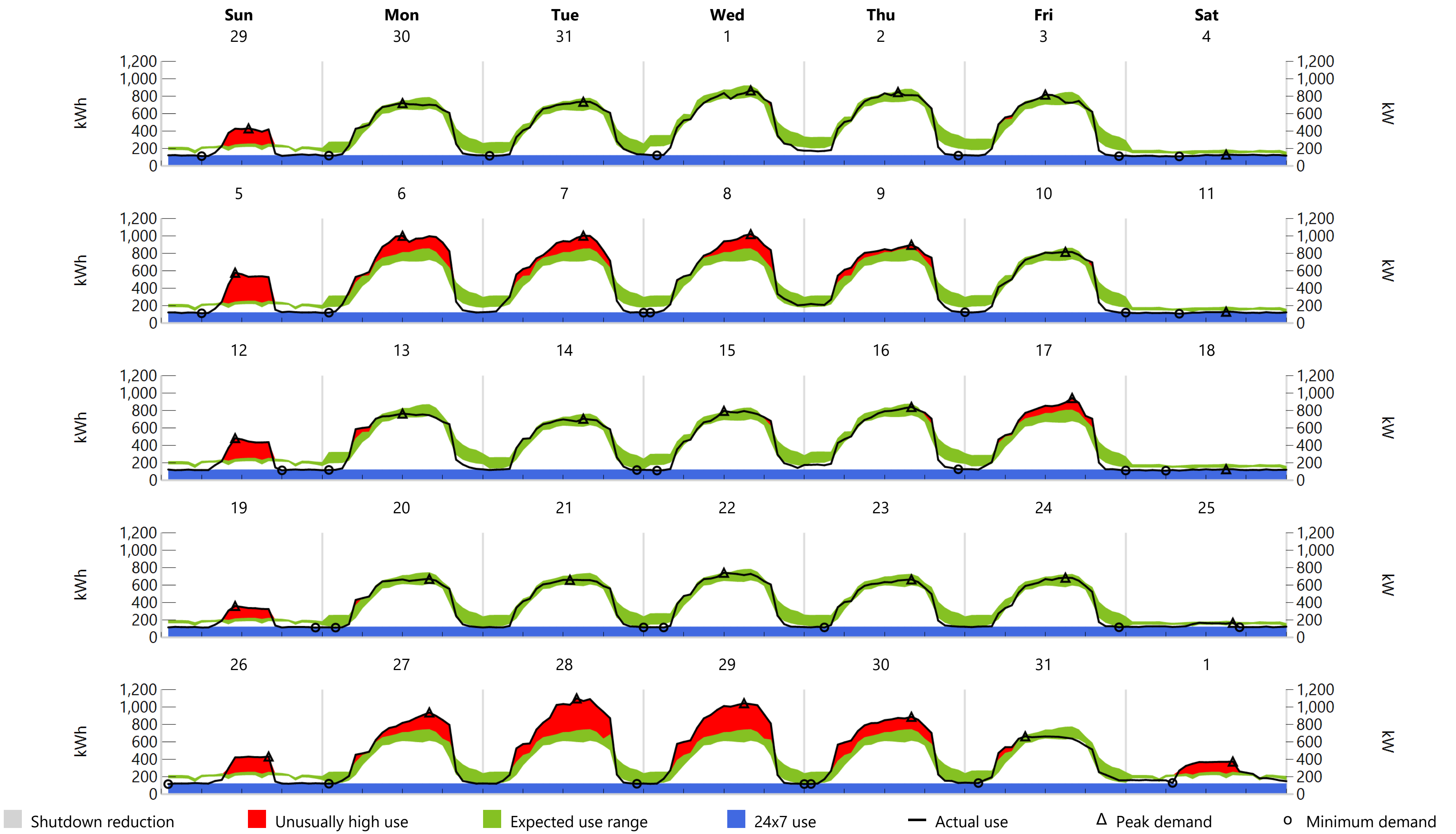
Load Calendar for Central Plant - Electricity
June 2018



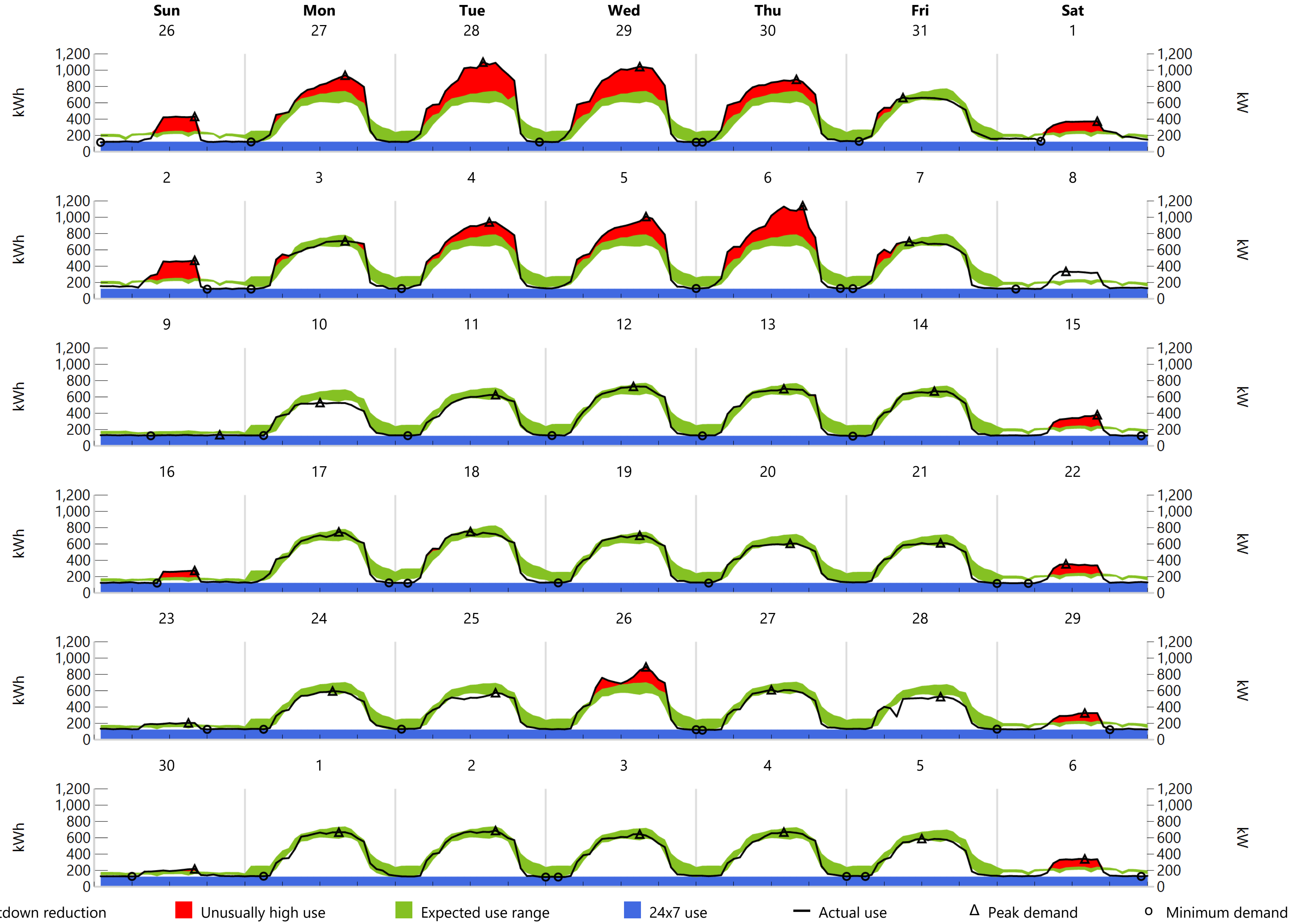
Load Calendar for Central Plant - Electricity
July 2018



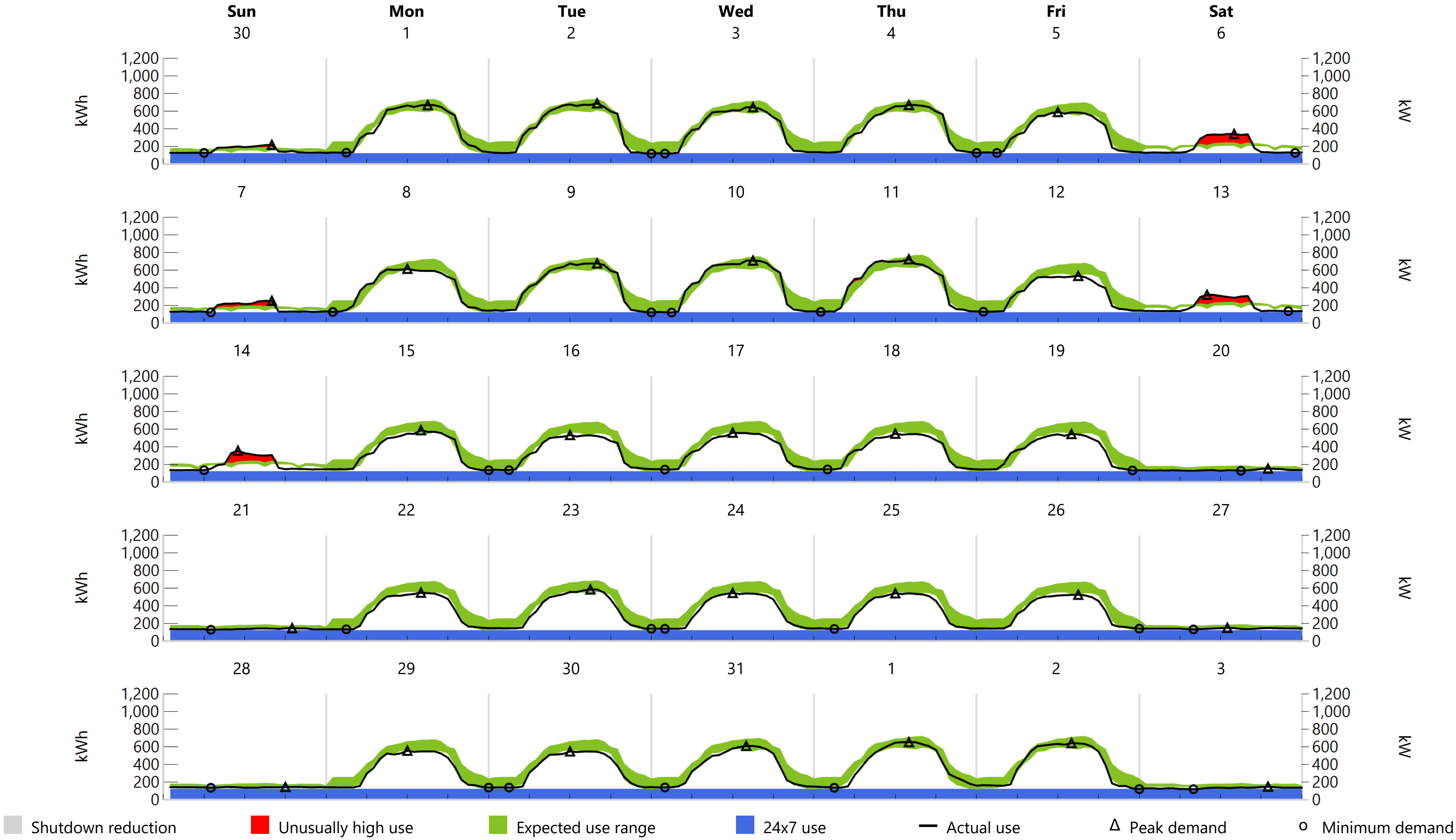
Load Calendar for Central Plant - Electricity
August 2018



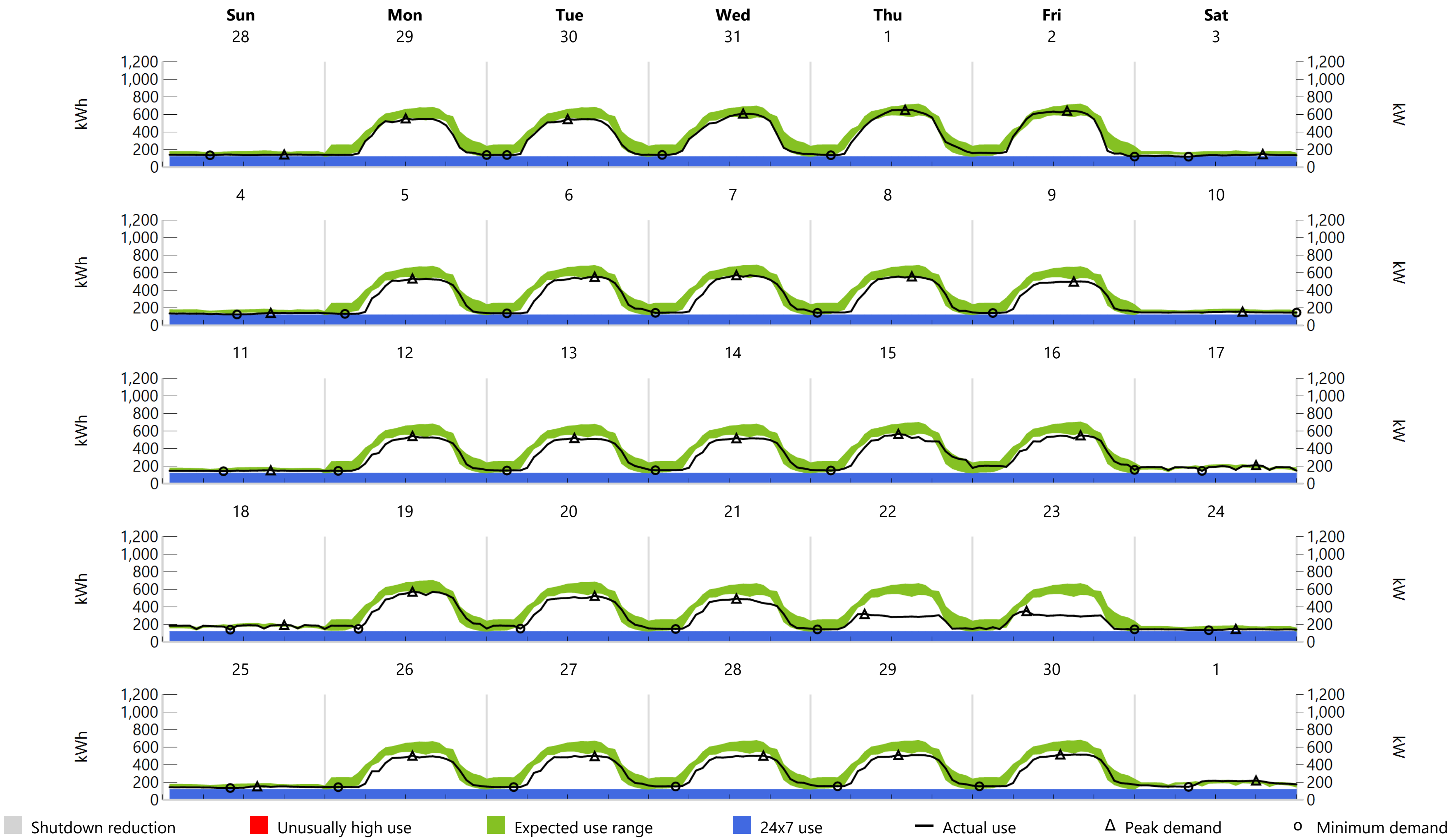
Load Calendar for Central Plant - Electricity
September 2018



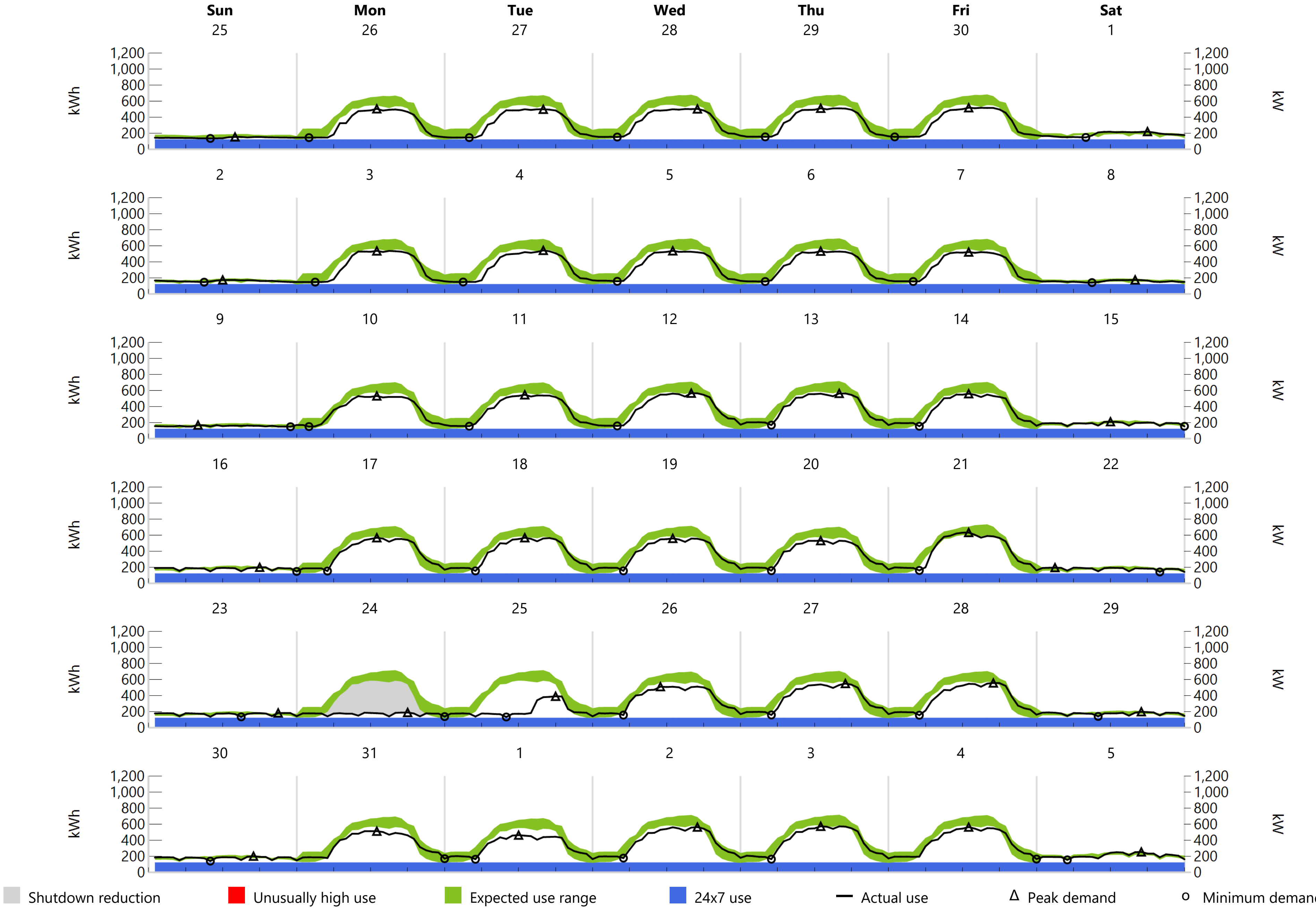
Load Calendar for Central Plant - Electricity
October 2018



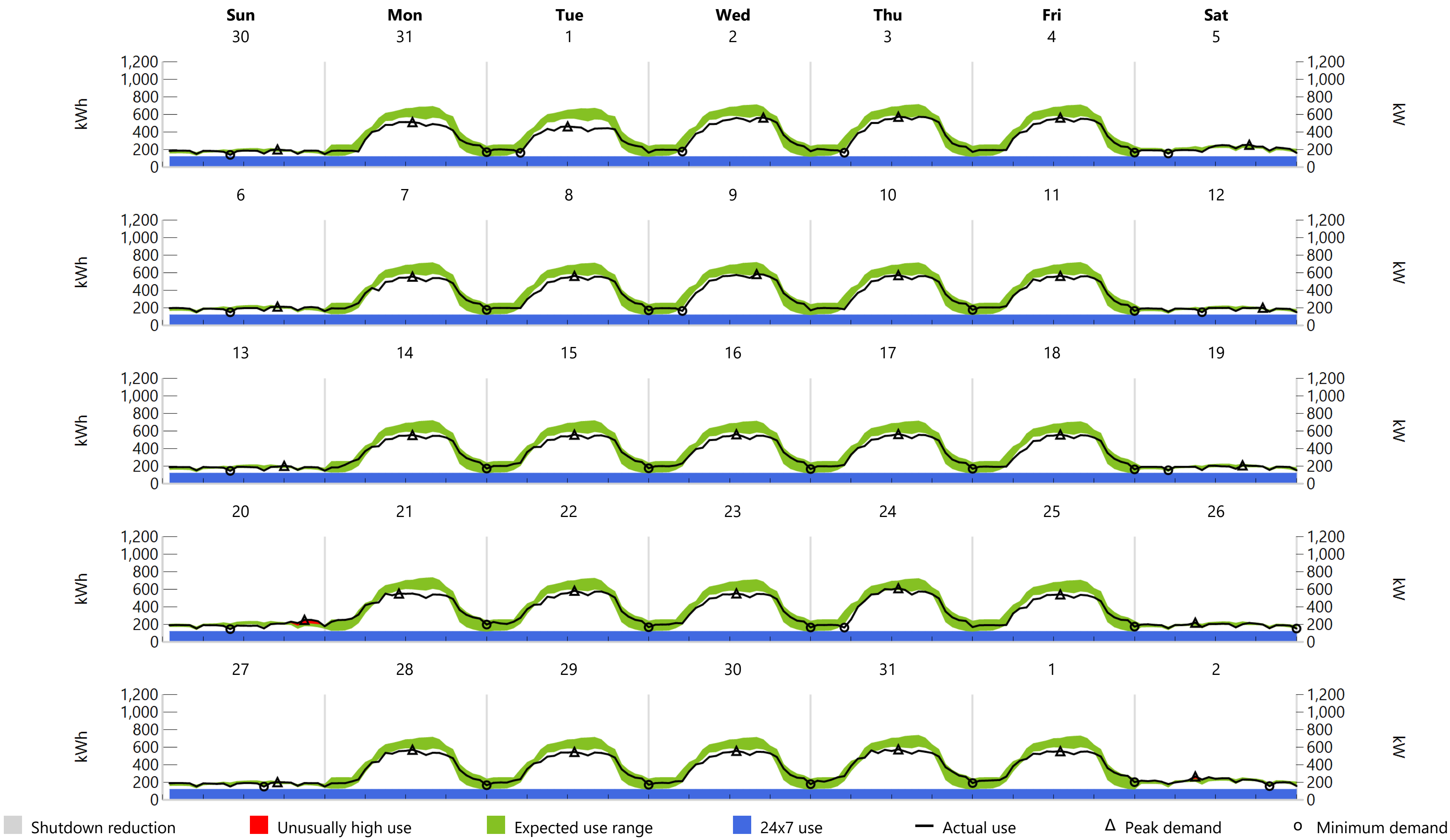
Load Calendar for Central Plant - Electricity
November 2018



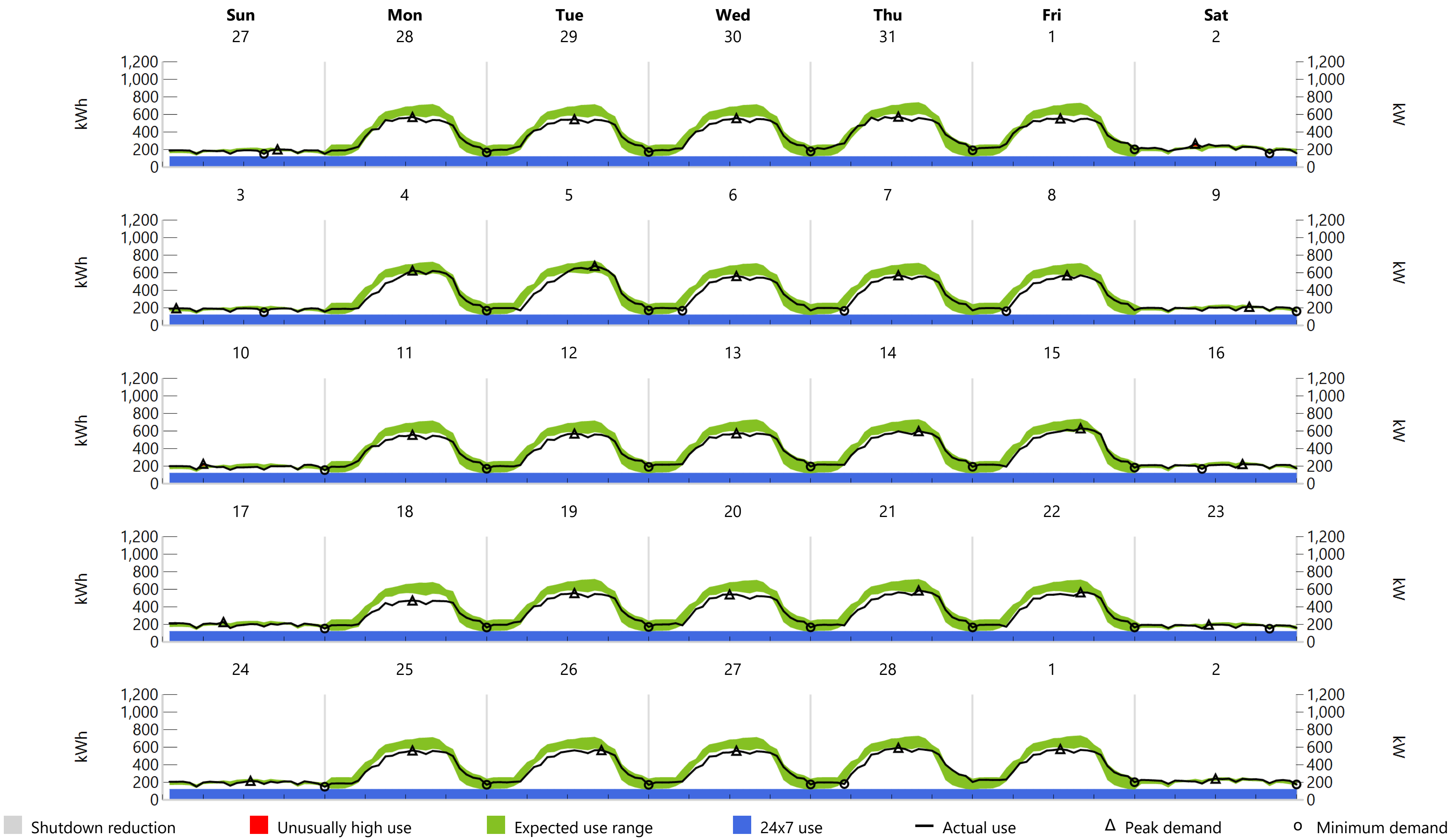
Load Calendar for Central Plant - Electricity
December 2018



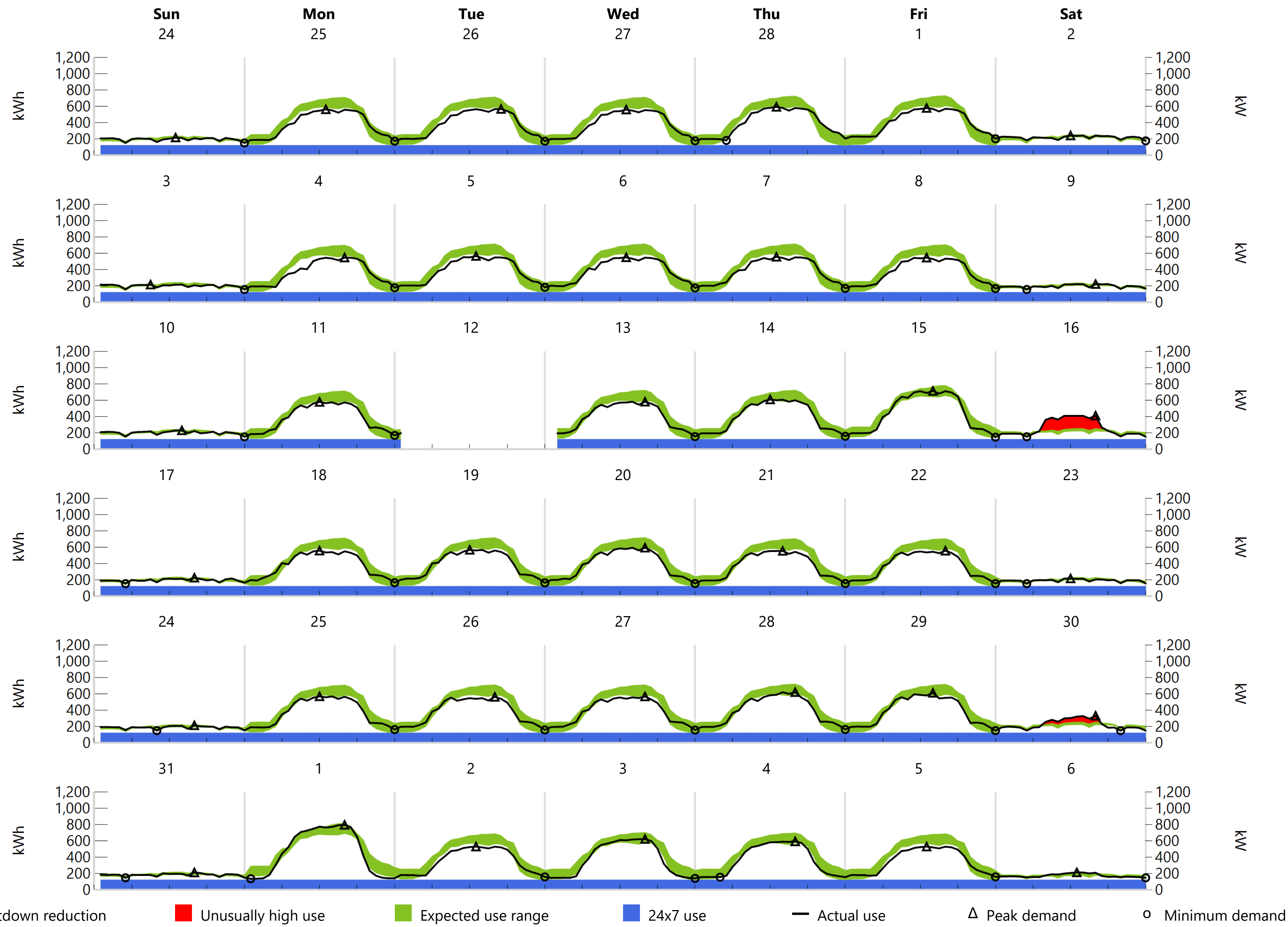
Load Calendar for Central Plant - Electricity
January 2019



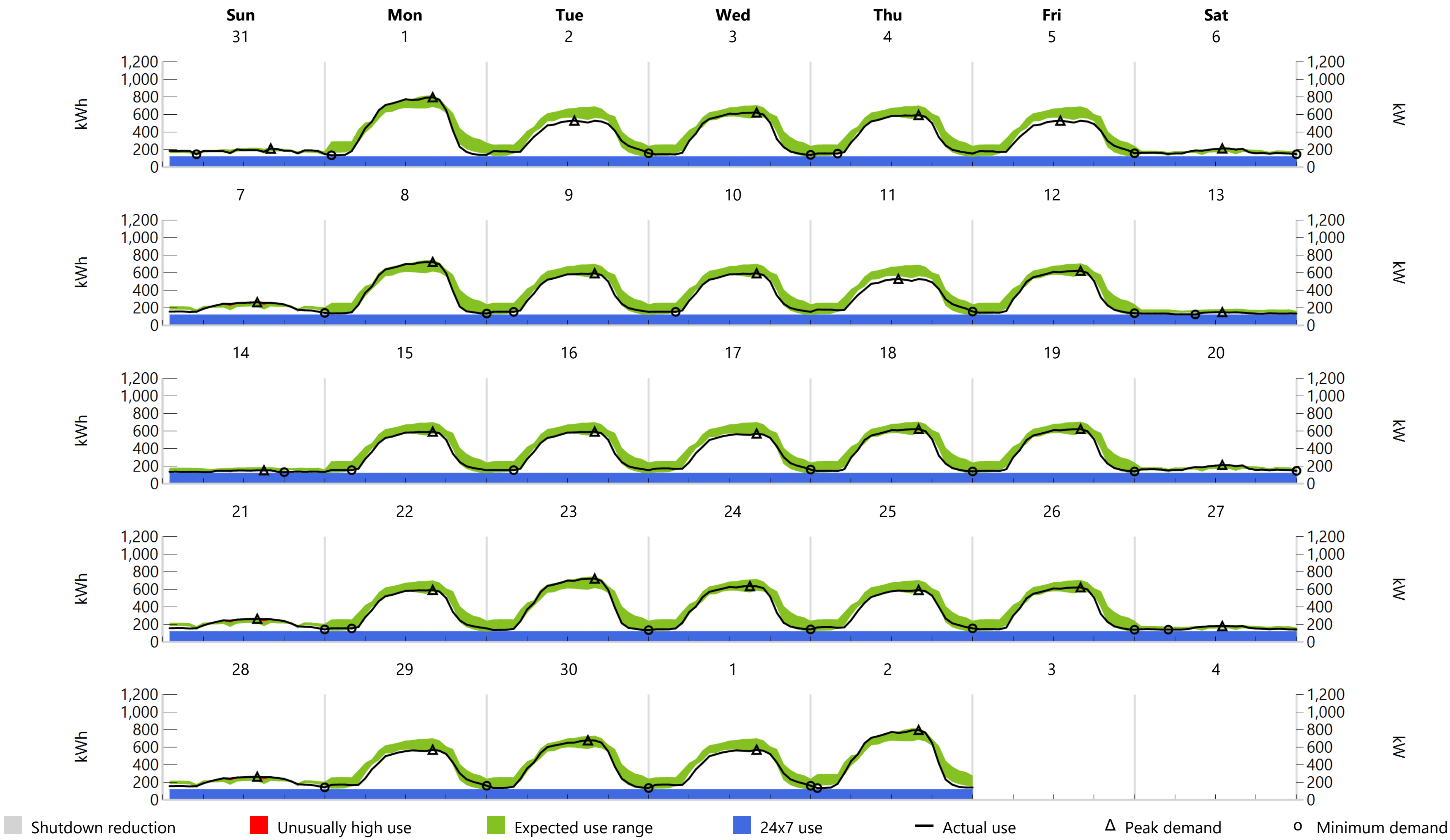
Load Calendar for Central Plant - Electricity
February 2019



Load Calendar for Central Plant - Electricity
March 2019



Load Calendar for Central Plant - Electricity
April 2019



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May 2019